Digital Raster Acquisition Project Eastern Ontario (DRAPE) 2014 Classified LAS

User Guide

Provincial Mapping Unit
Mapping and Information Resources Branch
Corporate Management and Information Division
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Executive Summary

Key Words

Classified LAS, Digital Surface Model (DSM), Digital Terrain Model (DTM), Digital Raster Acquisition Project Eastern Ontario, DRAPE, Elevation, Orthoimagery, Orthophotography, Imagery, Aerial Photography, Vector, Mass Points, Softcopy Photogrammetry

Abstract

Digital Raster Acquisition Project Eastern Ontario (DRAPE) 2014 orthophotography was collected through a collaborative funding partnership for eastern Ontario. Contributing organizations included the Ontario Government, municipalities, Conservation Authorities, the private sector and the Federal Government. DRAPE 2014 Classified LAS was generated by Mapping and Geomatics Services Section (MGSS) staff.

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List of Acronyms

ADS: Airborne Digital Sensor

CGVD: Canadian Geodetic Vertical Datum

DEM: Digital Elevation Model

DRAPE: Digital Raster Acquisition Project Eastern Ontario

DSM: Digital Surface Model

DTM: Digital Terrain Model

GeoTIFF: Georeferenced TIFF

GIS: Geographic Information Systems

GPS: Global Positioning System

IfSAR: Interferometric Synthetic Aperture Radar

IMU: Inertial Measuring Unit

LAS: Laser File Exchange Format

LAZ: Free and lossless LiDAR compression

LiDAR: Light Detection and Ranging

LIO: Land Information Ontario

MGSS: Mapping and Geomatics Services Section

MNRF: Ministry of Natural Resources and Forestry

NAD: North American Datum

OTF: On the Fly

TIFF: Tagged Image File Format

TIN: Triangular Irregular Networks

UTM: Universal Transverse Mercator

List of Definitions

Mass Points

Mass points are irregularly spaced points, each with x/y location coordinates and z-values, typically (but not always) used to form a TIN. When generated manually, mass points are ideally chosen to depict the most significant variations in the slope or aspect of TIN triangles. However, when generated automatically, e.g., by LiDAR or IfSAR scanner, mass point spacing and patterns depend upon the characteristics of the technologies used to acquire the data.

Digital Elevation Model (DEM)

Digital Elevation Model (DEM) is a generic term for digital topographic and/or bathymetric data that is comprised of x/y coordinates and z-values to represent an elevation surface.

The terms 'DTM' and 'DSM' should be used over the term 'DEM' to more specifically reference 'bare-earth' or 'surface elevation' model products when possible.

The term "DEM" is to be used as a broader term when referencing a generic elevation data product. The Provincial DEM is an example of a generic elevation product, given that it has been constructed using a combination of both 'DTM' and 'DSM' elevation datasets to achieve Provincial coverage.

Digital Terrain Model (DTM)

The bare earth surface (lowest surface, last reflective surface, or LiDAR last-return) represents the surface of the "bare-earth" terrain, after removal of vegetation and constructed features.

Photogrammetry has traditionally generated DTMs when elevations are generated by manual compilation techniques. Unless specified to the contrary, the bare-earth surface includes the top surface of water bodies, rather than the submerged surface of underwater terrain.

Similar to a DSM, a DTM can be structured either as a vector dataset (comprised of mass points and optionally 3D break lines) to model bare-earth elevations or a raster dataset that is interpolated from the vector elevation data to model bare-earth terrain elevations.

Using modern elevation point cloud classification algorithms and file formats, such as LAS, a DTM can represent a mass point dataset that has been classified for ‘bare-earth’ terrain elevations.

Digital Surface Model (DSM)

A DSM is the highest reflective surface of ground features captured by the sensor. This surface may also be referred to as the first reflective surface or LIDAR first-return. The DSM may include treetops, rooftops, and tops of towers, telephone poles, and other natural or constructed features; or it may include the ground surface if there is no vegetative ground cover. Photogrammetry, IFSAR, LIDAR and sonar can all provide this type of surface, yet characteristics such as accuracy and degree of detail (ability to resolve desired surface features) may vary significantly across technologies and even within the same technology. With sonar, the DSM may include sunken vessels and other artifacts, whereas the bathymetric surface reflects the natural underwater terrain. Similarly, with photogrammetry, LIDAR, and IFSAR the reflective surface may include any artifact present when the sensor mapped the area, including passing cars and trucks and similar features not normally considered to be part of a digital terrain model

Similar to a DTM, a DSM can be structured either as a vector dataset (comprised of mass points and optionally 3D break lines) to model surface elevations or a raster dataset that is interpolated from the vector elevation data to model surface elevations.

Using modern elevation point cloud classification algorithms and file formats, such as LAS, a DSM can represent a mass point dataset that has been classified for ‘surface’ elevation features.

1. Product Description

DRAPE 2014 was collected through a collaborative funding partnership that involved Municipalities, Conservation Authorities, the Province of Ontario, selected Federal Departments as well as private sector organizations. In total, there were more than 60 funding partners involved. The imagery contractor acquired digital imagery between April 28th and June 7th 2014 in leaf off conditions. The project encompassed an area of approximately 37,290 square kilometers.

1.1 Geographic Extent

DRAPE 2014 Classified LAS contains 37,227 non-overlapping tiles (1km x 1km) covering the Counties of Frontenac, Lanark, Lennox and Addington, Renfrew, the United Counties of Leeds and Grenville, Prescott and Russell, Stormont, Dundas and Glengarry, the Towns of Prescott, Gananoque and Smith Falls, the Township of South Algonquin and the Cities of Cornwall, Brockville, Kingston and Ottawa.

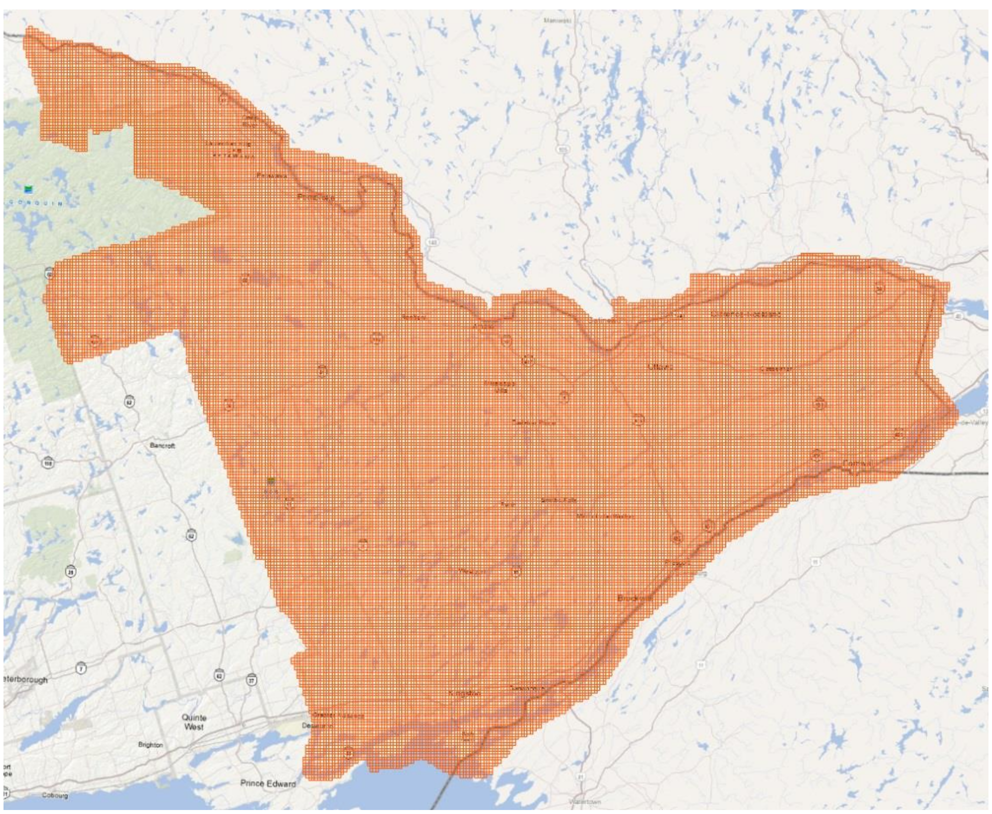

Figure 1: DRAPE 2014 Classified LAS Tiles

1.2 Reference System

1.2.1 Horizontal Reference System

The horizontal coordinate system of the vector data is the Universal Transverse Mercator (UTM) zone 18. The horizontal datum of the vector data is the North American Datum of 1983 (NAD83).

The horizontal unit of measure (coordinate system axis units) is metres (m).

1.2.2 Vertical Reference System

The vertical coordinate system of the vector data is based on the Canadian Geodetic Vertical Datum 1928 (CGVD28) of the Geodetic Survey Division, and is measured in metres above mean sea level. For more information please see the Geodetic Survey Division of Natural Resources Canada (http://webapp.geod.nrcan.gc.ca/geod/).

2. Product Details

2.1 Classified LAS, DSM and DTM

After releasing the DRAPE 2014 DEM and the DRAPE 2014 Raw LAS, MGSS staff worked with the raw point cloud LAS data to create a Classified LAS, Digital Surface Model (DSM) and a Digital Terrain Model (DTM) as seen in Figure 2.

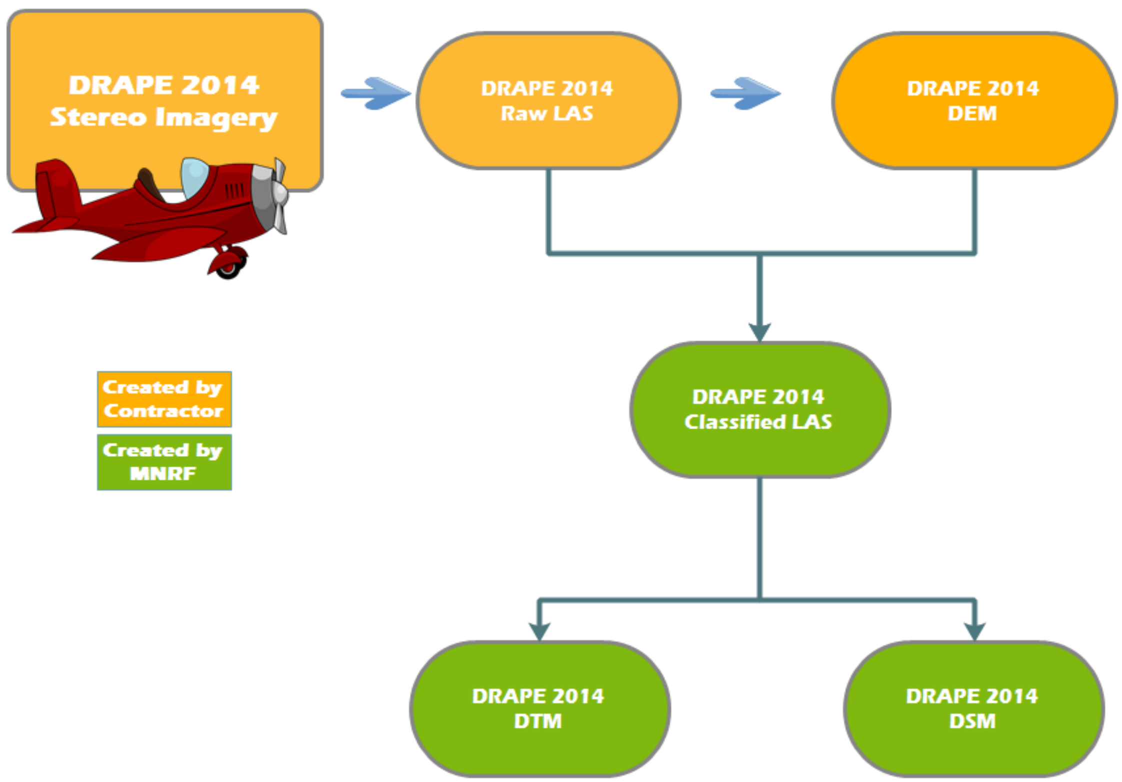

Figure 2: DRAPE Products

2.1.1 Classified LAS

The raw point cloud from the overlapping flight lines were resampled to 50cm and retiled into 1km by 1km tiles and reassembled back into LAS format. This reduces redundant points as well as reducing the number of points. During the retiling, a comparison with the DRAPE 2014 DEM was done to automatically assign the LAS classification. If the DEM was within 50cm vertically, it was assigned a LAS code of 2 (ground) otherwise it was a LAS code of 0 (unassigned).

2.1.2 DSM

The DSM raster was created by the using all the points (ground and unclassified) from the Classified LAS to create a raster product. This is a 2m resolution product matching the same tiling and resolution as the DEM. In the production of this raster, the adjacent 8 tiles are also used to prevent any edge effects.

2.1.3 DTM

The DTM raster is produced from only the ground classified points, and then compared with the DSM to ensure that no DTM point would be higher than the DSM.

2.2 Acquisition Details

DRAPE 2014 orthophotography was acquired with sensor Leica geosystems ADS100. Leica ADS100 Digital Camera systems, including inertial measuring unit (IMU) and dual frequency airborne GPS receivers were used for the digital image acquisition.

Imagery acquisition was performed at 2,377 meters above mean terrain to produce 20 centimetre orthorectified imagery and related products. The ground control survey was also collected by the imagery contractor. The products generated from DRAPE 2014 include: stereo imagery, 1km x 1km Orthophotography tiles in both GeoTiff and JPEG2000 formats. The products were delivered by the imagery contractor in UTM Z18 NAD83 CSRS.

The Leica GeoSystems XPro software was used for downloading and preparing imagery collected with the ADS100 Airborne Digital Sensor for softcopy photogrammetric use. The raw image was downloaded in the field with XPro to a portable workstation. This enabled a quick look at image quality and coverage. Using the Leica Geosystems IPAS software package the GPS data was differentially processed against a base station. After the differential GPS solution was checked and verified the Leica Geosystems IPAS program was used to compute an integrated GPS/IMU navigation solution at one-second intervals. Using the GPS/IMU trajectory computed by the Leica Geosystems IPAS software and the camera calibration, XPro computed a full x, y, z, omega, phi, kappa exterior orientation of each scan line. Using the orientation data file produced the L0 imagery was resampled. The resampling removes most aircraft motion and provides epipolar geometry imagery for stereo viewing, automated aerotriangulation and automated DEM extraction.

The Level 1 epipolar- resampled and georeferenced imagery usually will provide a pixels true ground location to within a few pixels without any additional processing. To improve accuracy, a fully automatic aerotriangulation process was performed to minimize the residual errors in the GPS/IMU derived exterior orientations. The aerotriangulation also allowed the introduction of ground control and checkpoints to ensure the accuracy specifications were achieved. Automated aerotriangulation of ADS100 imagery was performed with the XPro. A digital elevation model (DEM) was required for orthophoto production. DEM was auto correlated and used to generate the ortho-rectification imagery. The orthorectified imagery was created utilizing Leica Geosystem XPro software. The orthos were mosaicked together using a proprietary image database and mosaicking software. The database was edited for seam lines, and other artifacts. The imagery was clipped out of the database into the sheet layout generated based on client use requirements. In the clipping stage, the coordinate system and georeferencing was embedded into the header of the TIFF file. The stereo and orthorectified imagery was quality controlled and delivered on external hard drives.

GPS phase data was post processed with continuous kinematic survey techniques using "On the Fly" (OTF) integer ambiguity resolution. The GPS data was processed with forward and reverse processing algorithms. The results from each process, using the data collected at the airport, were combined to yield a single fixed integer phase differential solution of the aircraft trajectory. The differences between the forward to reverse solution within the project area were within project specifications (<10cm) in both the horizontal and vertical components, indicating a valid and accurate solution. An IMU was used to record precise changes in position and orientation of the ADS100 Digital Camera System. All IMU data was processed post flight with a filter to integrate inertial measurements and precise phase differential GPS positions. The resulting solution contains geodetic position, omega, phi, kappa, and time for digital image processing.

2.3 Data Delivery Format

DRAPE 2014 Classified LAS is 114 Gigabytes total in size. If you are interested in obtaining a copy please contact Land Information Ontario at lio@ontario.ca. You will need to provide a large enough hard drive for the data to be copied onto.

2.3.1 Data Format

DRAPE 2014 Classified LAS comes in LAZ format which is a lossless LiDAR compression. For more information on LAZ and free tools to convert LAZ to LAS visit the LASTools website (http://rapidlasso.com/lastools/).

2.4 Use Restrictions

DRAPE 2014 Classified LAS is considered Open Data. You are free to copy, modify, publish, translate, adapt, distribute or otherwise use the Information in any medium, mode or format for any lawful purpose. If you do any of the above you must use the following attribution statement “Contains information licensed under the Open Government Licence – Ontario.”

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